Evaluation of Potential Aseismic Creep Along the Ouachita Frontal Fault Zone, Southeastern Oklahoma

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INVESTIGATIONS UNDERTAKEN

This investigation is designed to evaluate previously reported field evidence of historic aseismic creep along the 50-km-long western part of the Ouachita Frontal fault zone (OFFZ) in southeastern Oklahoma (Figure 1). We are evaluating the possibility of aseismic creep along the Choctaw fault, a component of the western OFFZ that trends northeast across Atoka County, Oklahoma. This fault is the westernmost of a series of thrust faults within the Paleozoic southern Ouachita fold and thrust belt (Figure 2). The orientation and location of the Choctaw fault are favorable to re-activation in the present-day stress field observed in the mid-continent. Based on our initial field reconnaissance, we cannot rule out the possibility of aseismic tectonic creep on the fault, as suggested by previous workers. In the town of Atoka, the fault traverses a small, linear hill upon which there is an alignment of historic damage to cultural features (e.g., sidewalks, curbs, pipelines, rock walls) from left-lateral ground movement (Figures 3 and 4). On the basis of about 140 mm of left-lateral offset of a sidewalk (dated October 27, 1914), we estimate a rate of left-lateral offset of about 1 to 2 mm/yr (Figure 5). In a qualitative sense, this rate seems reasonable given the degree of deformation observed in houses and other cultural features along this alignment i. Early workers concluded that the damage is not related to

downslope movement, freeze-thaw processes or dissolution collapse, and instead is due to faulting in the absence of earthquakes (i.e., aseismic creep). Our field observations are consistent with this conclusion, and therefore we consider that the observed historic deformation may be related to aseismic creep. However, we also consider the null hypothesis that the deformation may be related to non-tectonic processes.

Our investigative approach involves analysis of aerial photography, collection of data from local hydrocarbon extraction, and limited field work. Our analysis of aerial photography along the OFFZ shows the presence of multiple prominent lineaments along mapped fault traces, although these most of these likely are related to lithologic control of slope and vegetation. Currently we are mapping these lineaments to identify other locations of possible historical or older deformation, and are interpreting the spatial distribution of damage relative to possible locations of hillslope instability or other non-tectonic processes. For example, the nearest hydrocarbon extraction fields (e.g., "Atoka Townsite N" and Atoka Townsite E") are small and located several kilometers from the deformation observed in Atoka, therefore suggesting that the deformation is not related to activities in these fields. In addition, the left-lateral offsets observed in Atoka are not consistent with ground subsidence that might be occurring as a result of extraction from these fields.

When a suitable target is identified, we will conduct limited subsurface exploration across the apparent fault trace or other potentially fault-related features in order to assess whether or not the features are related to tectonic creep or non-tectonic processes. If the features are found to be tectonic, this effort will provide an initial characterization of a potentially active seismic source in the mid-continent. The products of this research will be the documentation of features that address the presence or absence of active creep along the fault zone, and an assessment of whether the OFFZ is a potentially active seismic source. If evidence of active creep along the fault zone is attributable to tectonic processes, the OFFZ may be a previously unrecognized seismic source in the central US.

NON-TECHNICAL SUMMARY

This study is investigating whether or not damage to houses, sidewalks, pipelines and other features in Atoka, Oklahoma are related to recent fault movement. Damage to these features was identified in 1935 and confirmed recently by our observations, and may be related to active faulting. By characterizing the location and pattern of damage, we are determining if the fault is a previously unrecognized source of earthquakes in the central United States.

REPORTS PUBLISHED

None.

DATA AVAILABILITY

Additional detailed information on the investigation is available from the Principal Investigator.

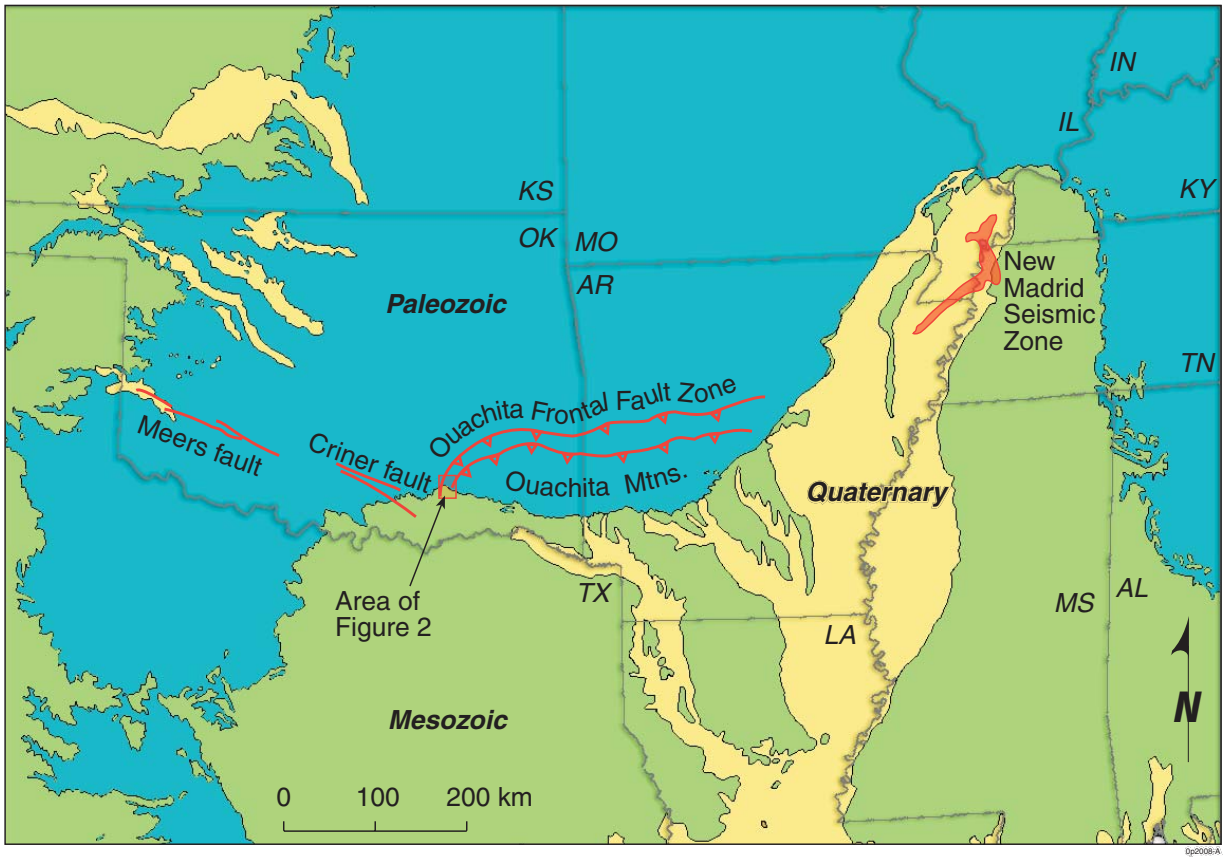

Figure 1a. Regional tectonic setting showing relationship between the Ouachita Frontal Fault Zone, the Meers-Criner fault, and the New Madrid Seismic Zone. The Meers fault and the New Madrid Seismic Zone are the two seismic sources in the central United states with documented evidence of late Holocene tectonic surface-deformation.

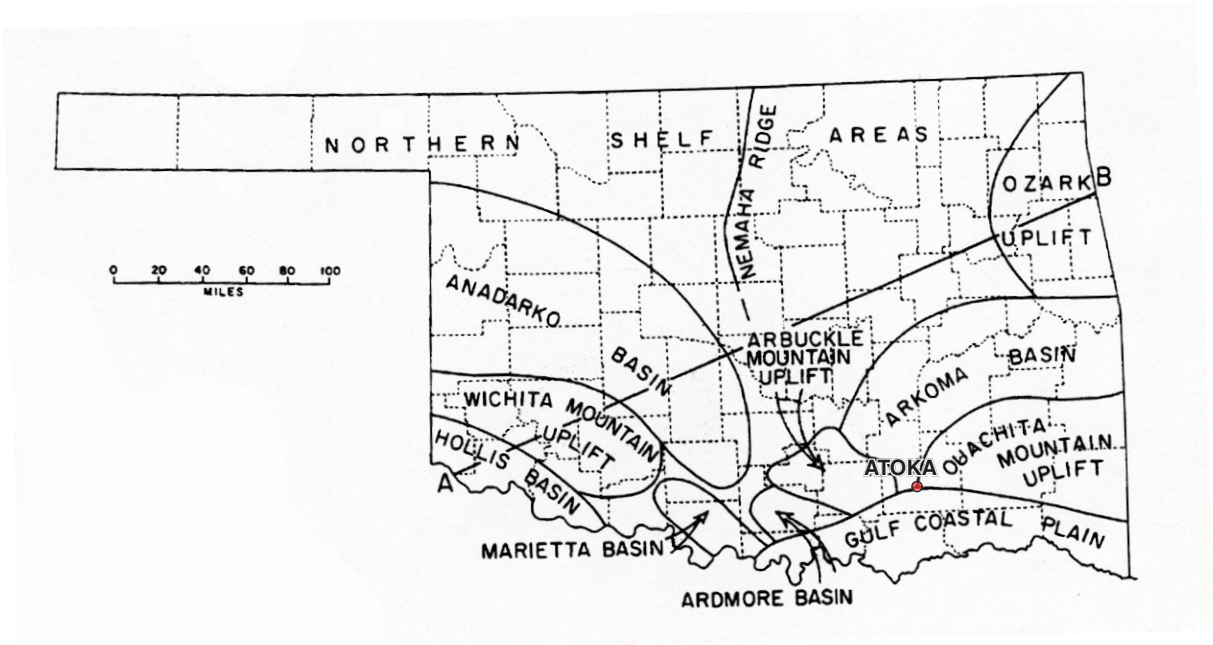

Figure 1b. Major tectonic features in Oklahoma (from Luza and Lawson, 1981)

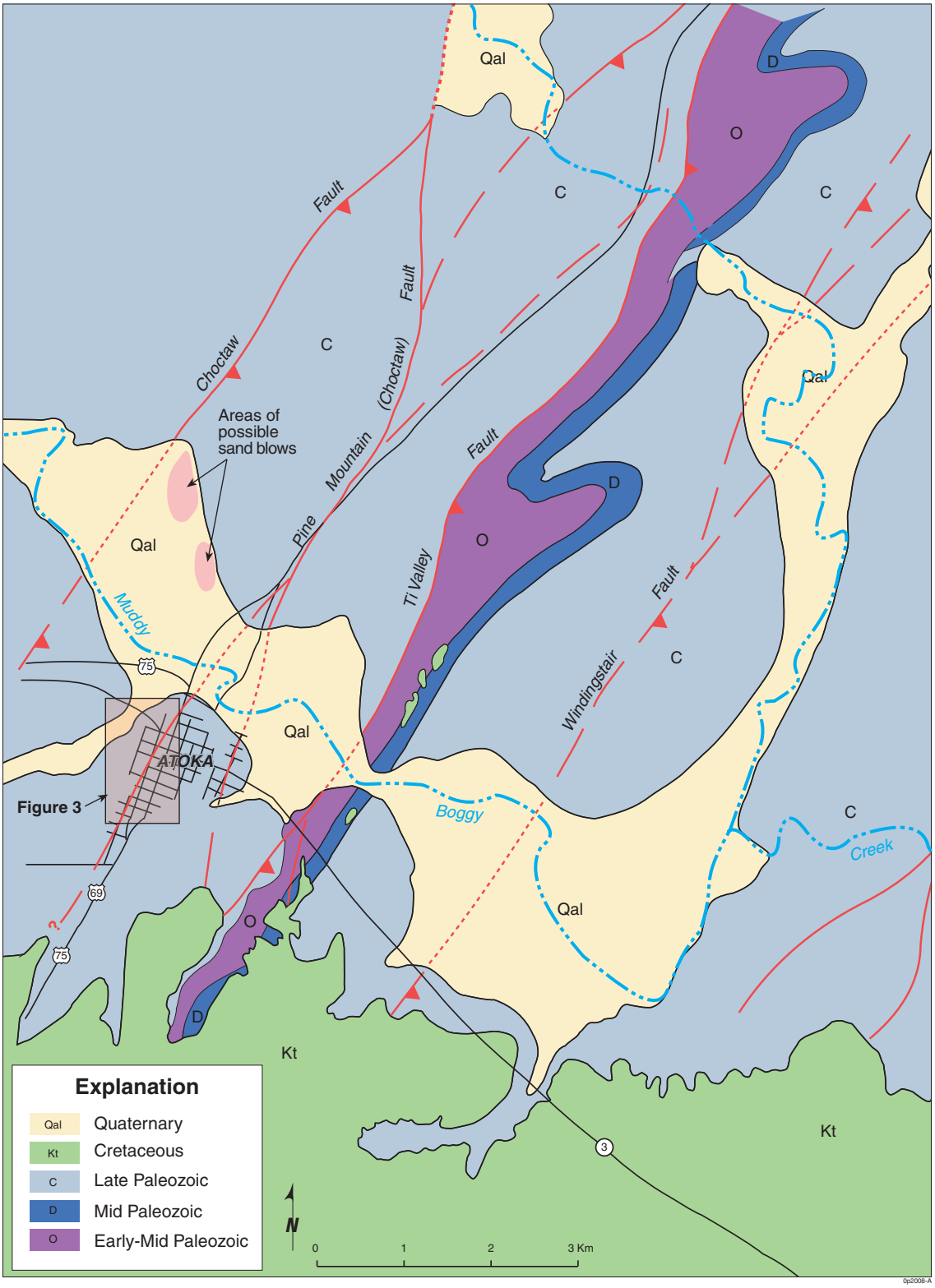

Figure 2. Generalized geologic map of the Atoka region, southeastern Oklahoma (after Hendricks et al., 1947; and Knechtel and Rothrock, 1935), this map shows the primary fault strands within the Ouachita Frontal Fault zone.

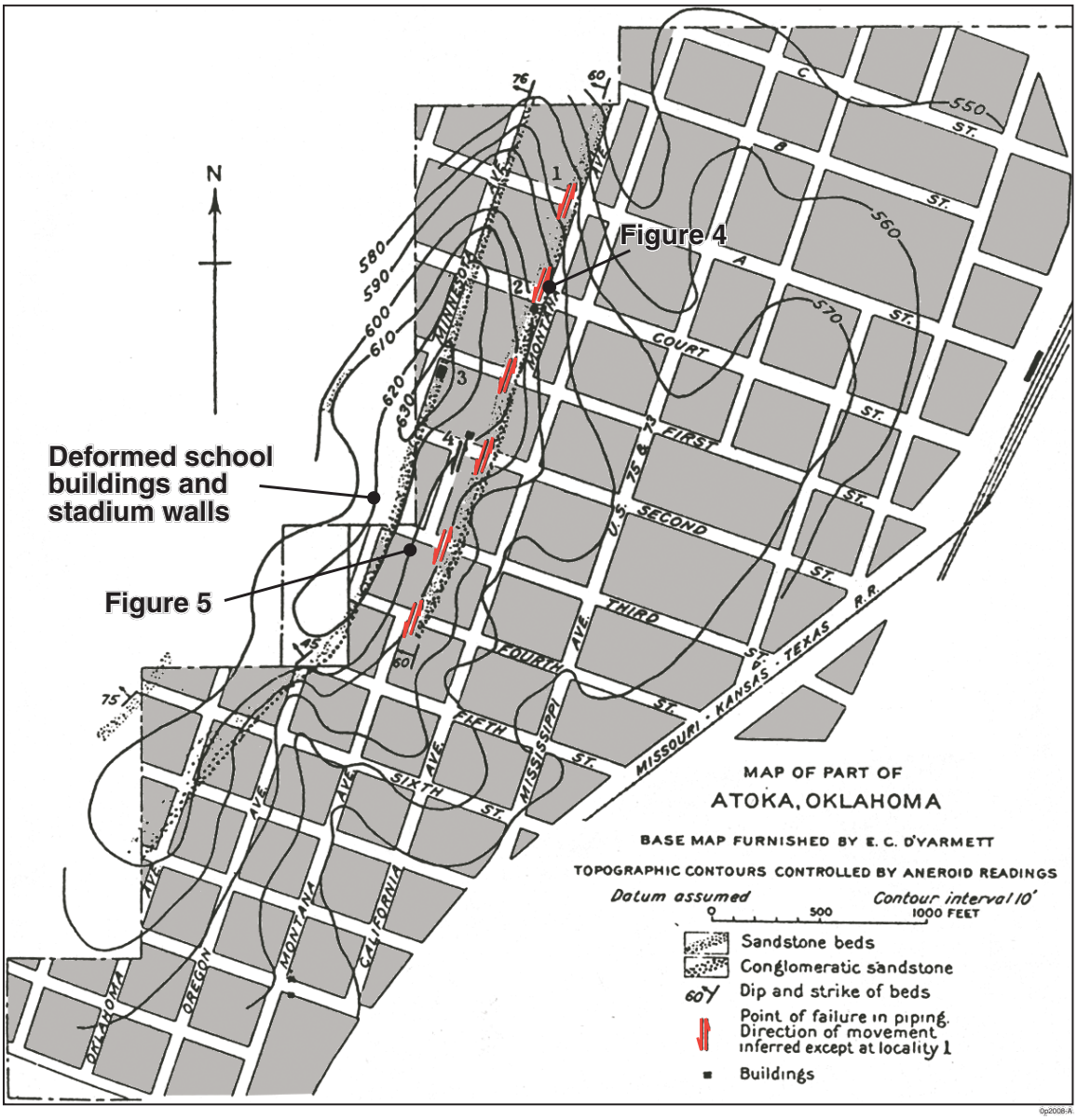

Figure 3. Map of part of Atoka, Oklahoma, showing locations of pipeline failures and direction of inferred fault movement (after Knechtel and Rothrock, 1935). Note that lateral offsets in cultural features noted by Knechtel and Rothrock (1935) are inconsistent with possibility of a landslide origin because they cut across topography. Locations of photographs taken in 1997 are shown (Figures 4 and 5).

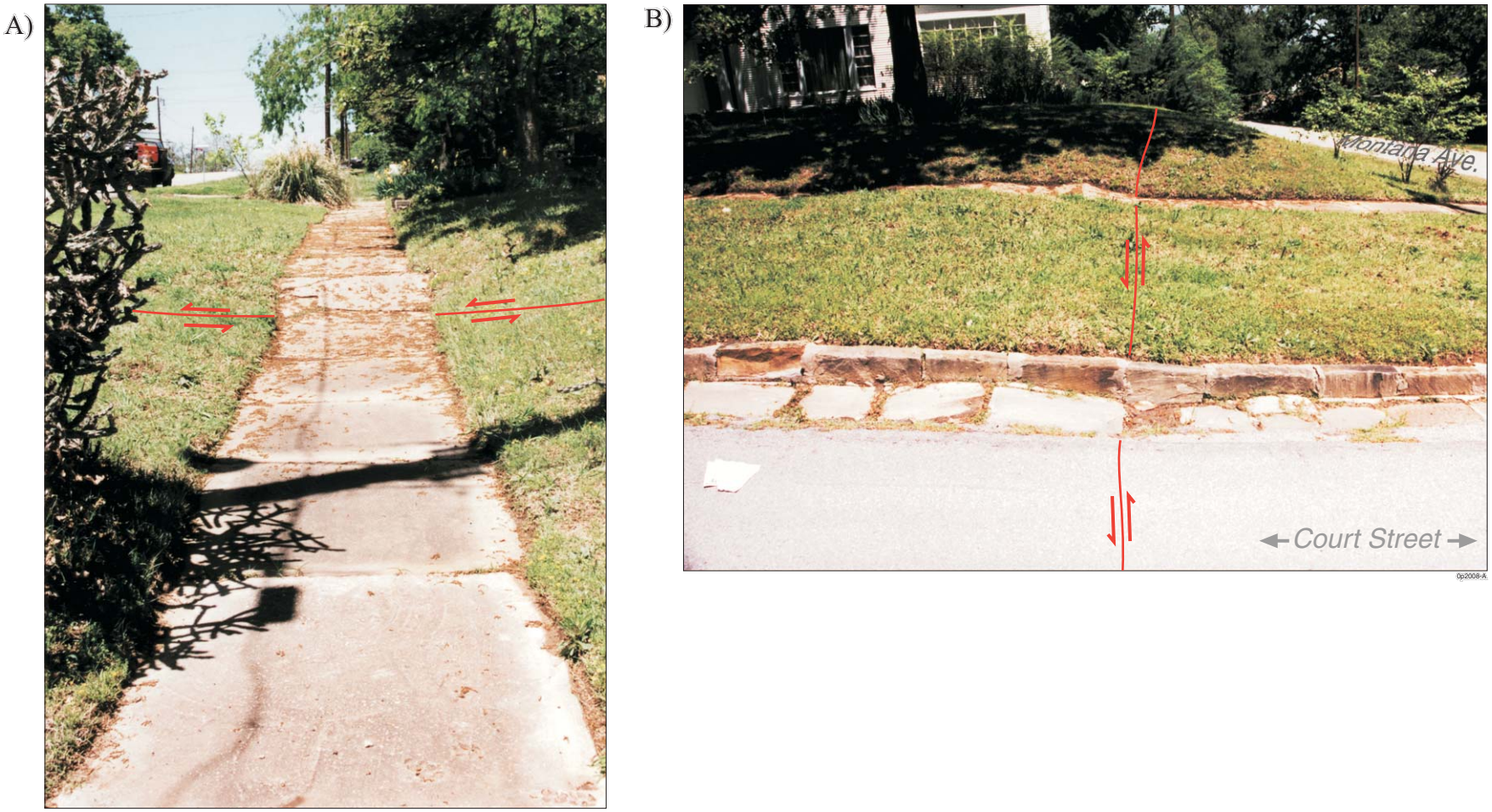

Figure 4. Photographs of sidewalk and curb deformation at corner of Court Street and Montana Avenue. A) Lookingwest northwest along sidewalk on Court Street, Showing left lateral offset and Down-to-the-west displacement. B) looking north-northeast at scarp in sidewalk and deformation in stone curb along Court Street.

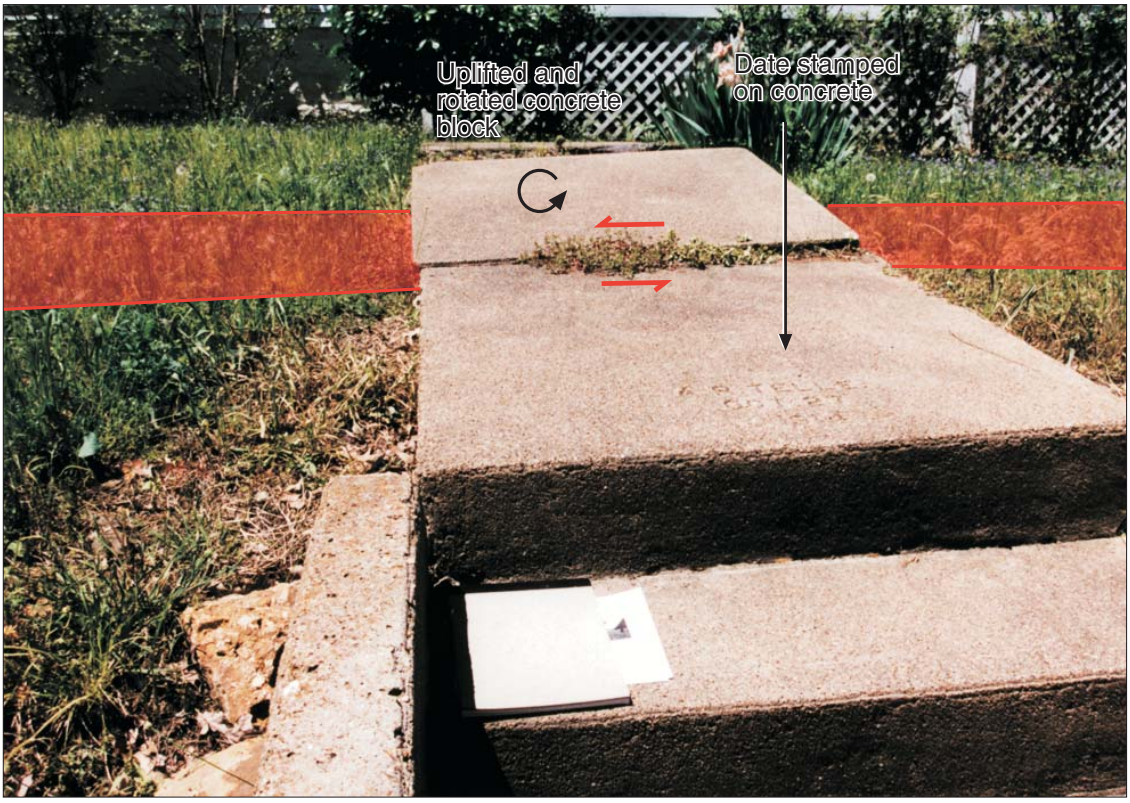

Figure 5. Photograph looking west-northwest along path orthogonal to Montana Avenue, showing left-lateral offset, uplift and rotation of concrete blocks. Concrete is stamped with date October 27, 1914. Measurement made on April 28, 1997, shows a total 14 cm of lateral offset across the entire path between wooden fence in background and steps in foreground.